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Book Review
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After the Clockwork Universe: The Emerging Science and Culture of Integral Society

Sally J. Goerner
Floris Books, Edinburgh, Scotland, 1999, paper; pp. 476, index; £14.99 ($20.95)

This remarkable book might well have been titled *A Guide for the Perplexed*, after the 12th-century classic by philosopher Moses Maimonides and its more recent counterpart by British economist E. F. Schumacher, both of which offered genuine wisdom during times of great confusion. Here we are given an entire summing up of the *world problematique* at the end an era, as well as sage advice on how to enter the oncoming age without disaster. Of course, many writers these days are trying to grapple with the nature of the painful changes that the globe is going through. Most of them have some theory or other that they hope will explain everything in easy terms. Nearly all of these efforts have some truth to them, and many are useful in particular contexts such as personal finances, management, industrial productivity, and so on. It might seem pretentious on my part to say that this book is different, but indeed I believe that it is different in some very important ways.

Most important is the fact that the book is informed throughout by a scientifically sound synthesis which exfoliates into a wealth of insights about the growing failure of the today's social, economic, and governmental systems, while at the same time pointing to an optimistic future toward which it is possible for the world to move. This scientific synthesis suggests that the complex world in which we find ourselves embedded is both more highly-structured and jointly co-evolving than dreamt of in current philosophies. Webs of interconnection found in every sphere life, science and human activity, are being driven toward increasingly elaborate patterns of organization—or greater “intricacy” as Goerner calls it. This self-organizing process of increasing intricacy holds from the earliest formation of matter to the origins of life and on down to latest cycles of civilizations. It is the basis of the broad process of evolution, which we now see started before and stretches beyond biological evolution.

After an excellent introductory chapter which sets the historical stage in which we see the end of the analytic world created by the simplistic science and rationality of the Enlightenment, Goerner hunkers down to a detailed introduction to how complex interwoven systems work. In a series of four chapters she takes us from the basic principles of chaos theory to the application of these ideas for new understandings of biological evolution and the nature of life. The notion of increasing intricacy is spelled out and clarified by detailed explanations of undergirding scientific principles. She then moves on to an examination of the self-organizing basis of the human mind itself. All this lays a solid groundwork upon which the third part of the book builds. This last section explores the pressing issues of today's world in light of the new scientific understandings.

Unlike so many writers who speak glibly of "the new science," Goerner actually knows her scientific material extremely well—from advanced mathematics up through theories of social evolution and global economics. What is so remarkable is that she manages this highly technical material in a fashion that is understandable by any intelligent reader, while at the same time satisfying the picayune tastes of experts. More importantly, the reader is given the information necessary to put knowledge into practice. I must admit that I did not anticipate that a book of this size, on the topic of complexity, would be a page-turner. But in fact, the plain language descriptions, coupled with helpful drawings and a great many informative examples led me to consume the entire thing on one overnight plane flight form coast to coast. Although I was already familiar with many of the ideas, I had never seen them presented in such a unified and forceful fashion. The net result was a sense of understanding that only comes with seeing how so many disparate facts all interconnect to form a coherent web of their own.

The central insight around which this book grows is that energy flow drives systems toward increasing complexity. Goerner makes a good case that in one way or another energy underpins just about every kind of complex system, even information systems and financial networks. The key observation is that flowing energy creates eddies and swirls of local organization, which on careful examination are found to facilitate the rate at which energy passes through the system. The little whirlpool in the bathtub actually accelerates the flow of the water down the drain, and the tiny regions of turbulence that emerge in a wood fire increase the rate heat flows through it. These small hubs of activity are embedded in larger energy processes which operate according to similar principles. Local hubs thus form networks of activity within larger networks which fit into larger networks still. The resulting fractal system of webs within webs within webs characterizes organization in all types of complex systems.

The result of common principles operating at all levels are similar cycles and patterns of activity that can be seen in a pot of boiling soup, in living organisms, in human societies, and in large-scale economies. For example, as a system grows it reaches a point at which the forces holding it together begin to break down. At this point, the system must either give birth to a more tightly interlaced internal organization or it will collapse for lack of an adequate supportive structure. This pattern of local intricacy emerging from global pressures means that complex self-organizing systems, from protozoans to nations, and from rain forests to global economies, are characterized by rich networks of internal interconnections that need to be preserved if the system is to prosper. Perhaps the most fundamental message of this book is that to facilitate the health of macro-level systems we must honor and support the networks that exist at micro-levels as well.

Taken as a whole, such highly interconnected systems form what Goerner calls the *web world*. Throughout these pages Goerner reviews many efforts to understand such complex phenomena using the recently developed tools of the sciences of chaos and complexity. Highly entwined and driven by nonlinear dynamics, such complex systems have long baffled the best efforts of traditional science. Drawing on examples that range from physics' classic "three-body problem" to illustrations of biological processes, Goerner explains exactly why traditional “analytic” methods are completely inappropriate for inter-linked systems of more than three bodies. She then explains how new mathematical methods which *are* appropriate for the interwoven of the world, open up a vast new realm of scientific understanding. She shows how new methods and ways of thinking help us, for example, reconceptualize efforts to revitalize economies and urban environments. The result is a vastly changed scientific image of the world that is both practical and yet in harmony with good sense and traditional wisdom.

Though the basic science in this book is excellent, what sets it apart from other books on systems science is Goerner's ability to grapple with the over-riding problems that beset today's world. It would take far too much space to describe her treatment of how the science of the Enlightenment, as helpful and necessary as it was for its own time, has today given us a mentality that presses for competition, control, and dominance throughout nature and everywhere in human social, political, and economic institutions. What is important is the image she paints of an expanded science, one that is able both to explain the fallacy of rationalist thinking and also chart a sounder more desirable course through the complexity of the world. Goerner's third section shows what this means in community and economic systems. For example, we are treated to a history of traditional urban planning, based on the notion that planning is best carried out by experts who can design and lay out a community into logical divisions in terms of function and social class. The result of this type of planning is, of course, the world in which we now live—one in which we are constantly stressed to the edge of exhaustion by the endless "commuting" from home to work, to child care, to school, and so on; with no time for chatting with neighbors, or for community activities. As a result, streets have become a kind of no-man's land, unsafe for children or even adults. We all know this story.

Goerner, however, uses the scientific framework of intricacy to explain an alternative and more optimistic story of how traditional “undesigned” inner city neighborhoods can grow safe, strong, supportive and prosperous by self-organized intricacy. Once upon a time, neighborhoods tended to operate naturally, in terms of small scale economic and human support. These intricate human webs, however, were virtually invisible to the gaze of the banking establishment and did not conform to the official planners' ideal of separation and control. Nevertheless, when such neighborhoods formed they tended to thrive because of the rich networks of personal and financial connections that are the roots and branches of any vigorous social system. Though rare today, such intricate human-scale webs are beginning to make a come-back in cities now exhausted by the frenzy of planned separation.

Goerner also uses the framework of growth to explain why human organizations have recurrent developmental crises. As any organization grows, communication lines become stretched, separate interest groups form, and group action becomes unwieldy. There are three avenues out of this situation. The first is to try to reduce size to a manageable level, as has been done through the downsizing of large companies into "leaner and meaner" organizations. This may help the organization in the short term, but does not actually solve the pressure to grow more intricate. The second possibility is disintegration or collapse caused by failure to grow correctly. The third, and most important solution is to develop a new system of organizational intricacy, one that keeps smallness thriving under an ever growing umbrella of connective tissue. Maintaining smallness with connectivity improves creativity, communication, and coordination of common efforts. Local regions of rich interconnectedness can be networked together in the larger social structure, forming something that looks more like a nervous system than an architectural drawing.

Similar ideas apply in economics. Goerner takes considerable pains to show the deficiencies of traditional economic theory. Indeed, it would seem that a growing cadre of economists do not even argue with the fact that traditional economic thought, based on 19th-century linear, equilibrium models, is nowhere near adequate to the understanding of the contemporary global marketplace—if, indeed, such thinking ever was adequate. Today forward thinking economists are searching for a more ecologically sound theory of market dynamics. The solution is clearly not to race forward at ever greater rates of consumption until all the earth's resources are exhausted and large portions of the human race are dying of starvation, but to seek a more sustainable economy that grows up from the roots of small local business that can combine in larger cooperative enterprises.

Goerner gives excellent illustrations of the power and creativity of such bottom-up growth found in economic systems throughout the world. The Japanese bicycle industry, for example, began with many small shops operated by individuals who made parts with which to repair foreign bicycles. Eventually shops began to purchase parts from each others and to construct entire bicycles. This operation grew into a successful grass-roots industry based on dense, human-manageable interconnections and creative local entreprenuership. When this pattern of networked small-scale entreprenuership and dense connections is preserved the result is a "flexible manufacturing network" that is faster, more creative, and higher in quality and integrity than the large hierarchical organizations that dominate global industry today. Exactly how to nurture and preserve the pattern is somewhat unique to each situation, but the basic blueprint is before us, as Goerner makes clear again and again.

In the final chapter of the book Goerner offers five suggestions for creating an intricate, sustainable and healthy society. These suggestions would also seem to apply with minor modification to businesses and other social institutions as well. They are:

- Maintain intricacy: A sound social fabric is like a lace tablecloth, filled with small and intricately entwined circles.
- Encourage mutual benefit. Societies which stay well-linked do so because their everyday systems make it desirable to benefit self and others at the same time.
- Encourage commitment to the common good. We depend on our brethren and on their integrity. We are going to have to develop ways to make integrity and concern for the greater good worthwhile for each and all.
- Maintain a robust flow of resources and accurate information. A human society depends on a good flow of information and resources. People who swim a sea of lies lose their sense of direction. Gross inequities create instability. The only way to have a sustainable civilization is to build a mutual-benefit system with no great gaps.
- Maintain ongoing learning. Collaborative learning is humankind's central strategy. Now that we know this, we have to teach other children and our institutions to be collaborative.

When all is said and done there are few books that actually have the potential to significantly impact history in a positive way. I honestly believe that this is such a book.

Review first published in THE JOURNAL OF WORLD FUTURES: